

Evaluation of Chemical and Microbial Effects of Wastewater Infiltration Lagoons on Ground Water Quality – Butler County, Ohio

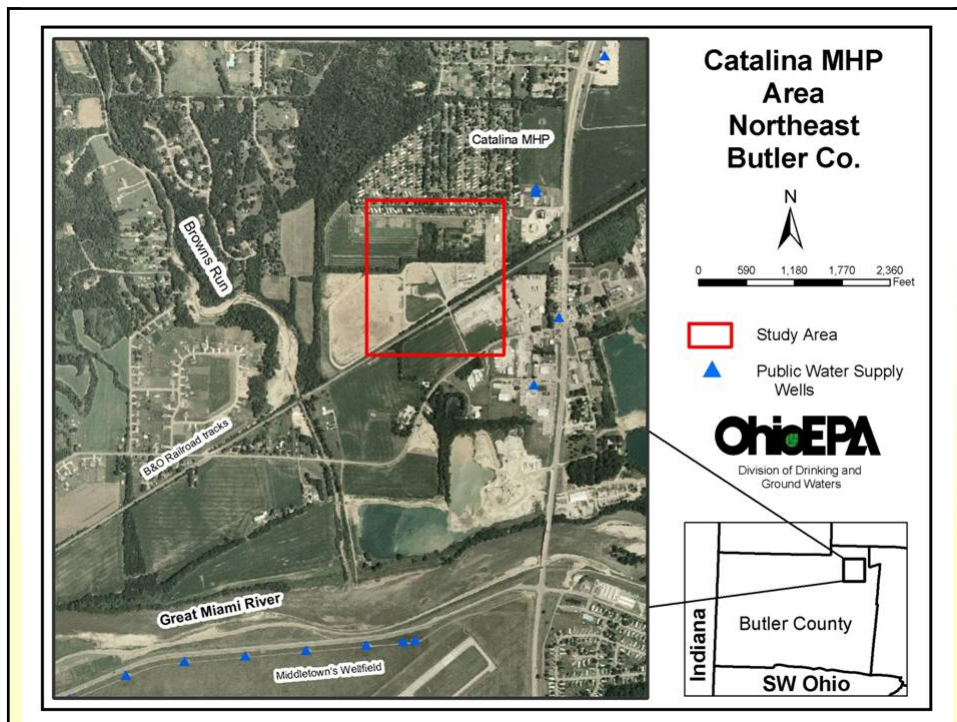
**Chris Kenah, Michael Slattery,
Linda Slattery, and Michael Eggert**

**Water Quality Characterization & Protection Section
Ohio EPA, Division of Drinking and Ground Waters**



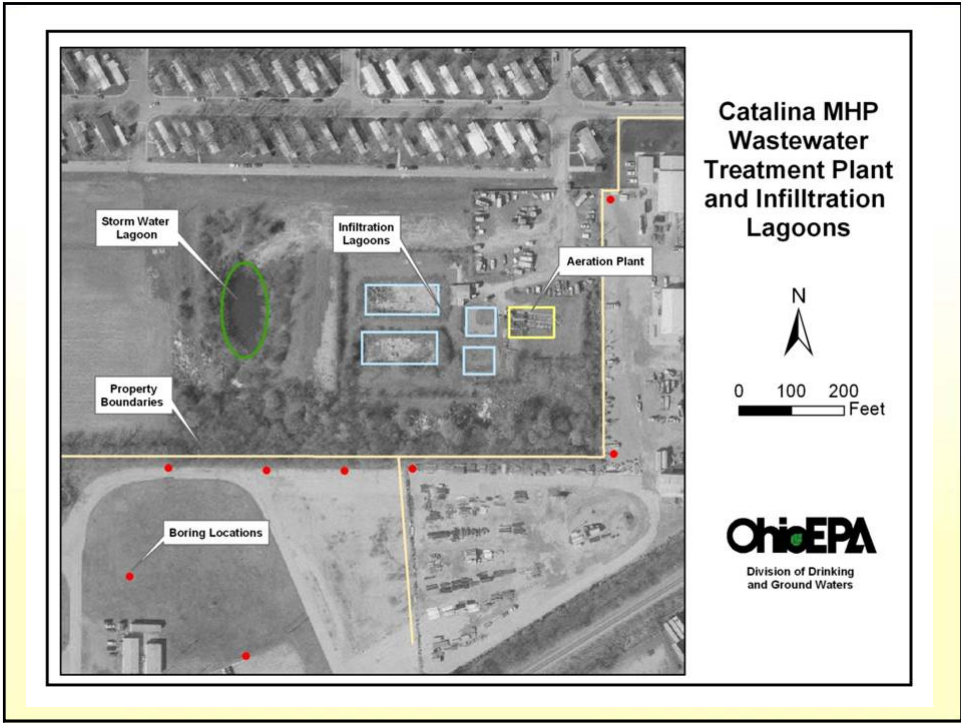
Outline

- **Overview of Situation**
- **Geologic Setting**
- **Sampling Approach**
- **Results of Study**
 - Inorganic, Isotope, Microbiologic Samples
- **Implications of Study**
 - Public Health
 - Ground Water Rule



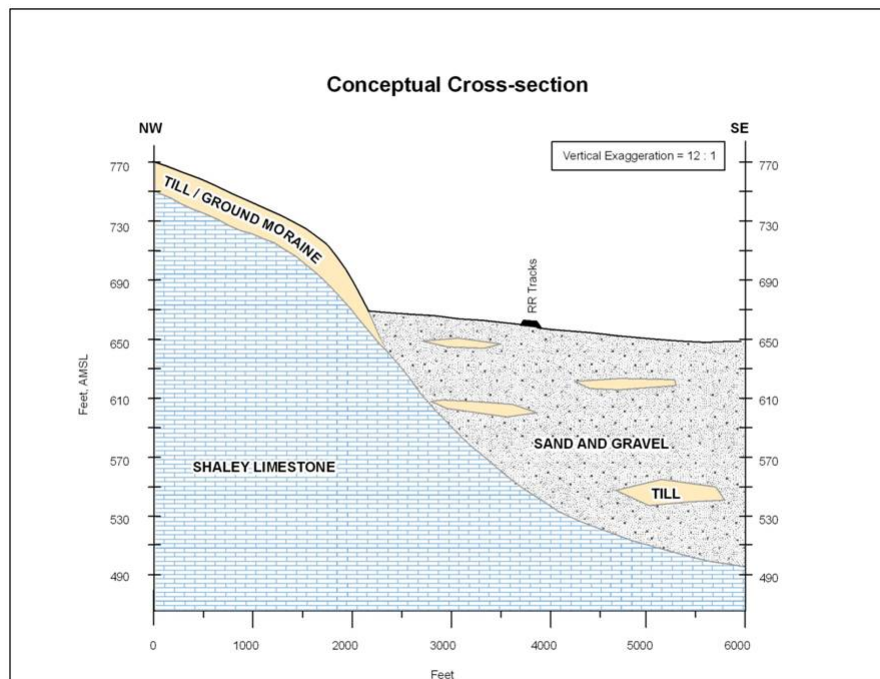
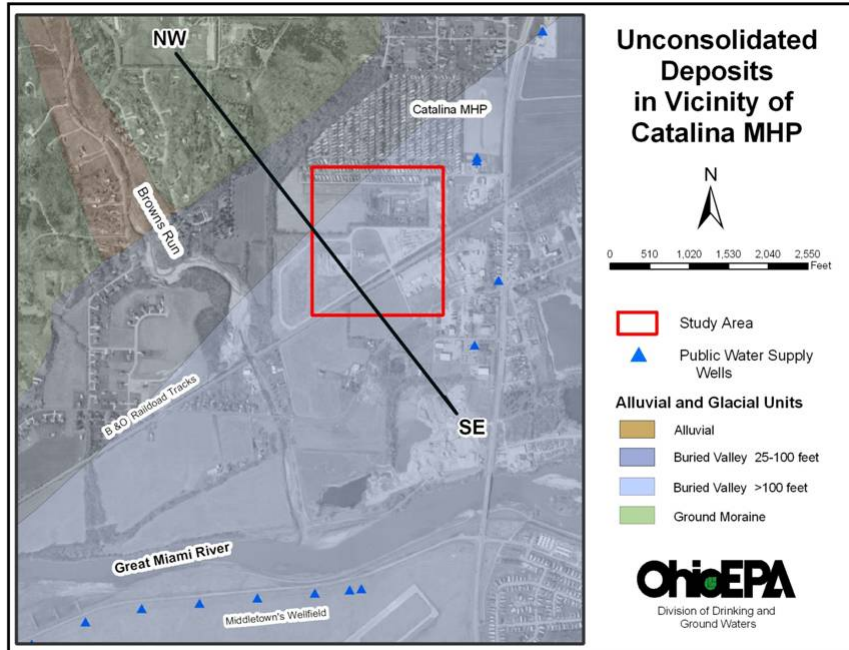
Situation - Discharge to Ground Water

- Partially treated wastewater discharged to unlined lagoons (since late 1960's)
- Lagoons overlie the Great Miami River Aquifer
- Infiltration is a discharge to ground water
- Does impact to ground water quality from infiltration pose a public health threat?



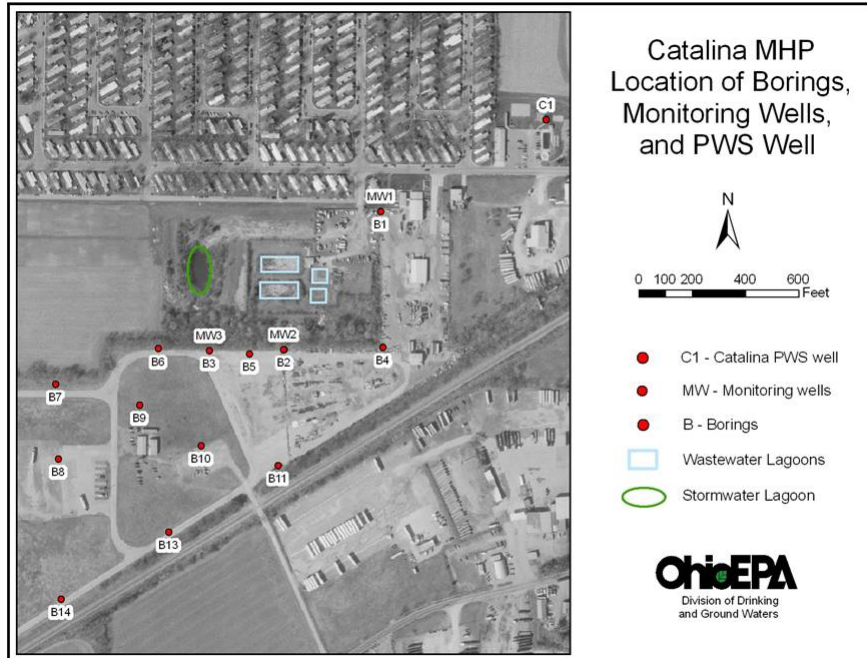


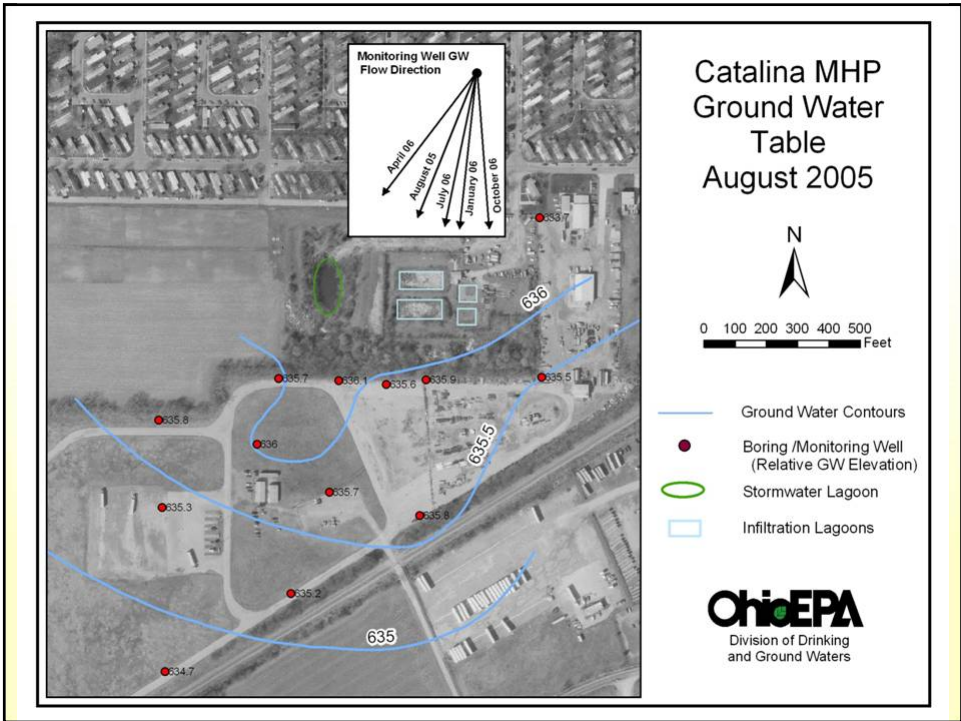




Sampling Plan – Evaluate GW Quality

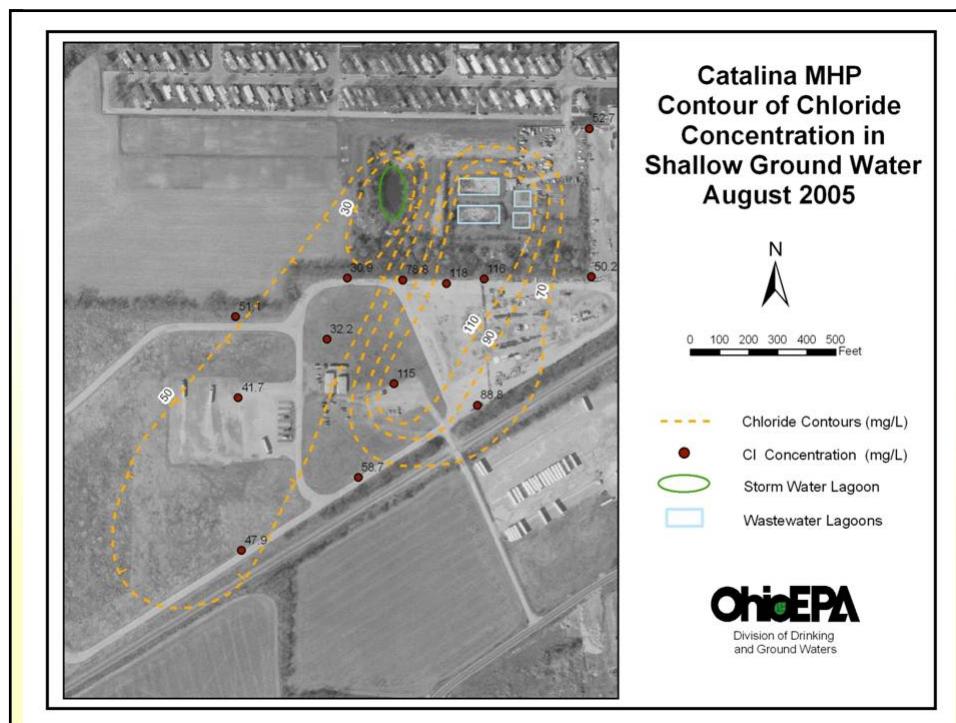
- Identify flow direction
- Locate Geoprobe borings within and upgradient of plume
- Install GW monitoring wells at top of GW table for quarterly samples – 1 upgradient and 2 downgradient
- Sample borings and monitoring wells for inorganic, microbiological, isotopic, and pharmaceutical parameters

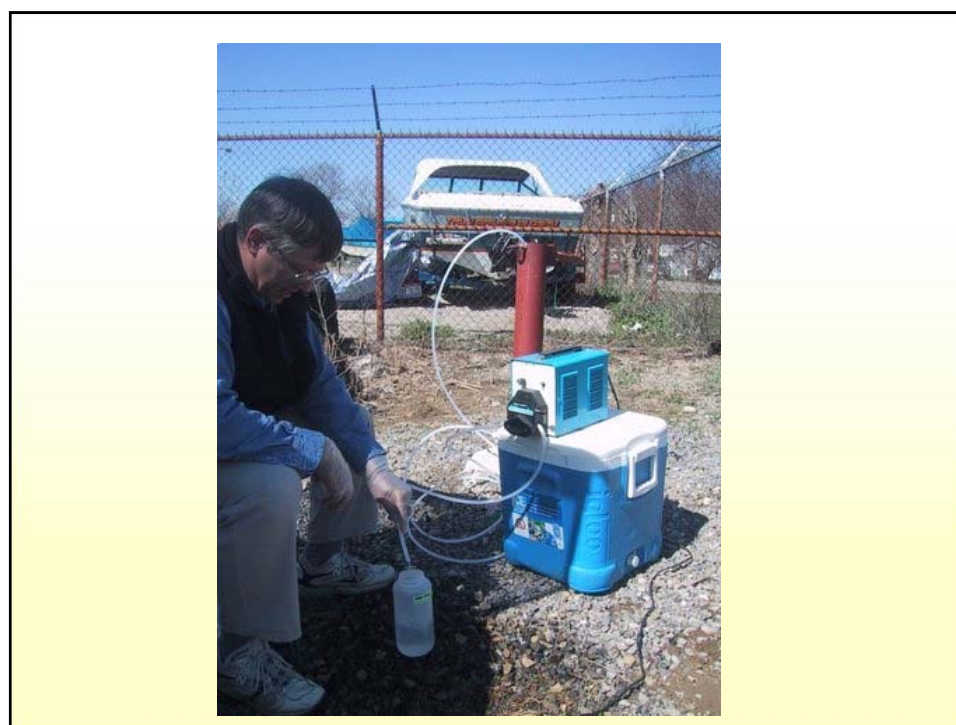
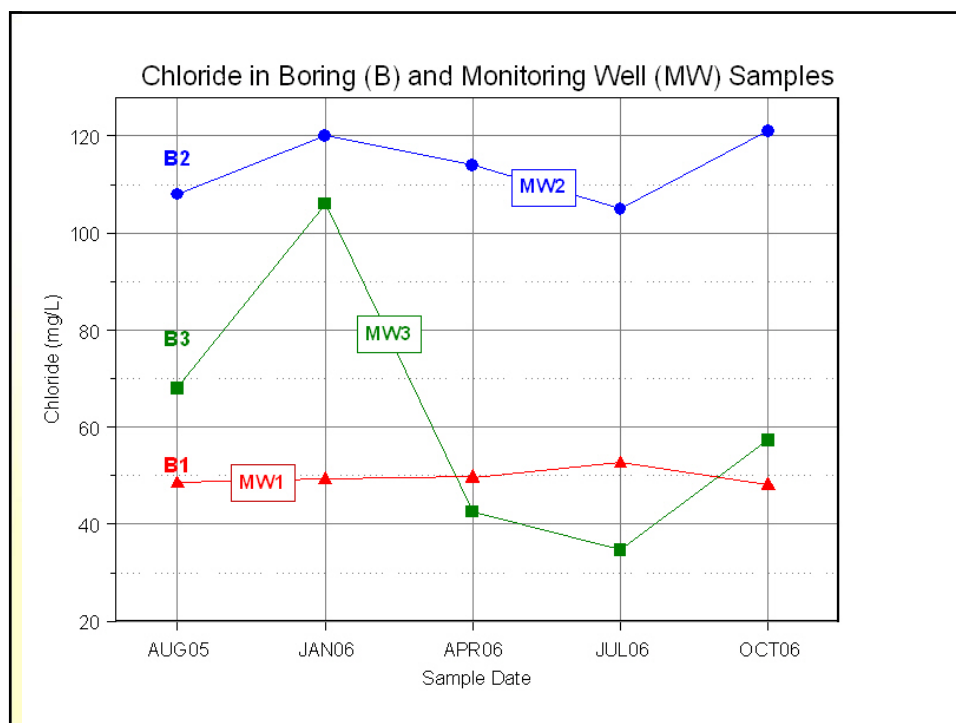


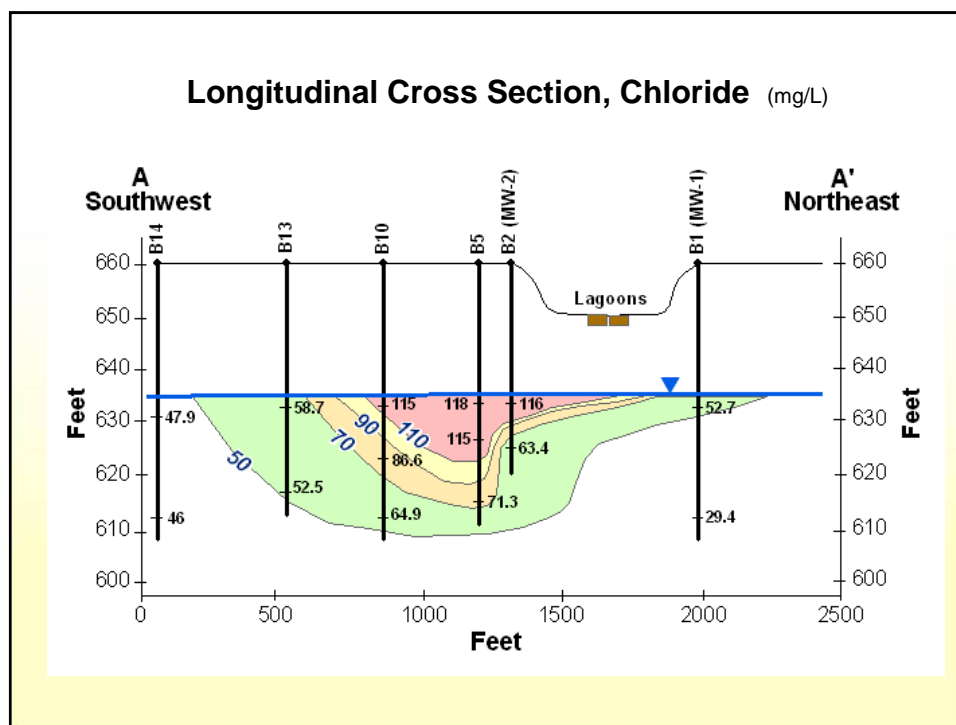
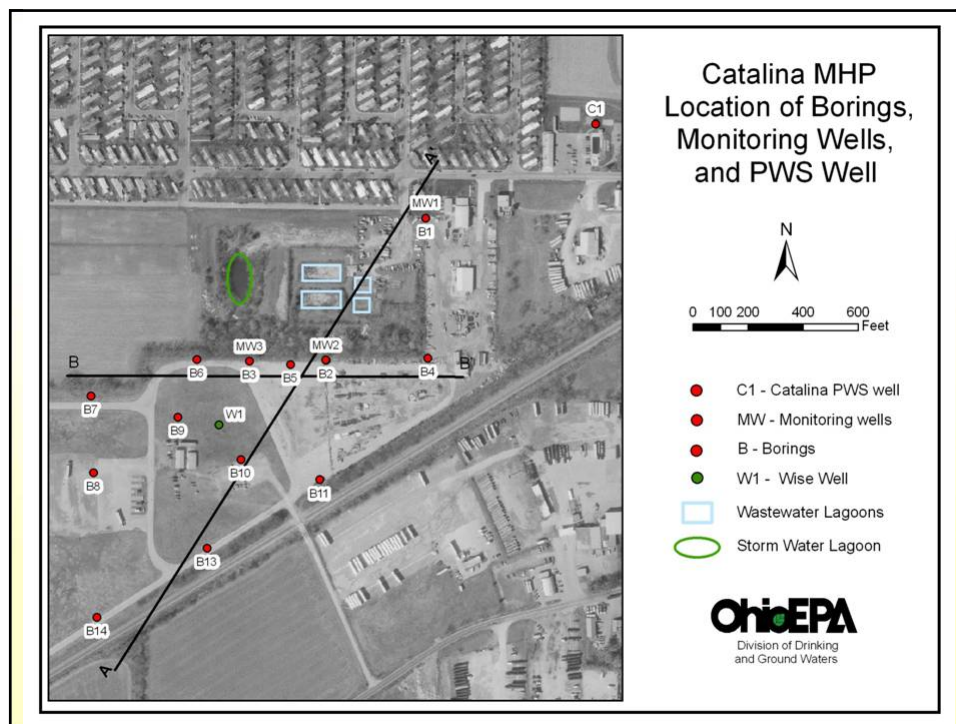


Inorganic Sample Results

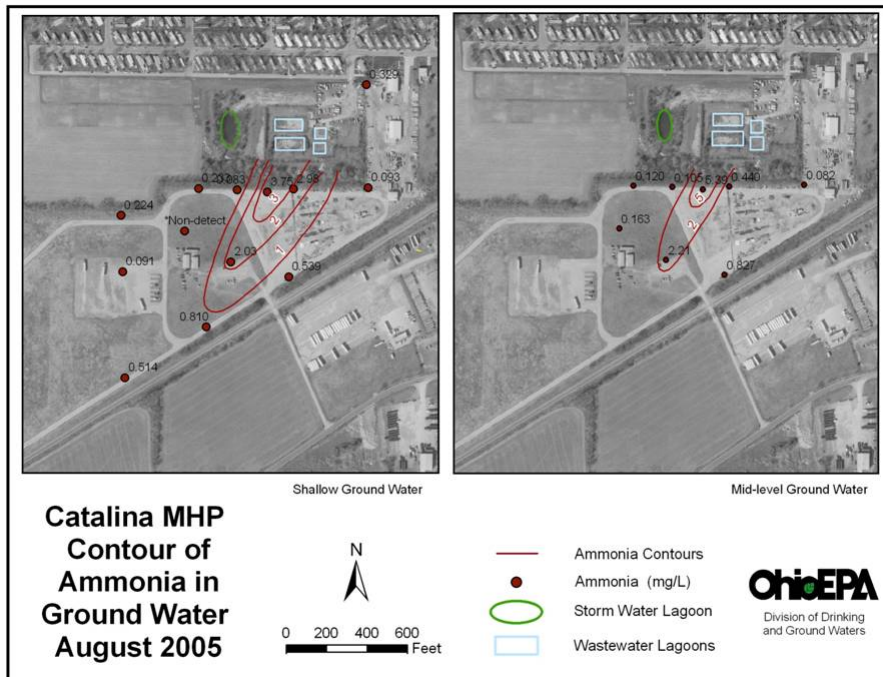
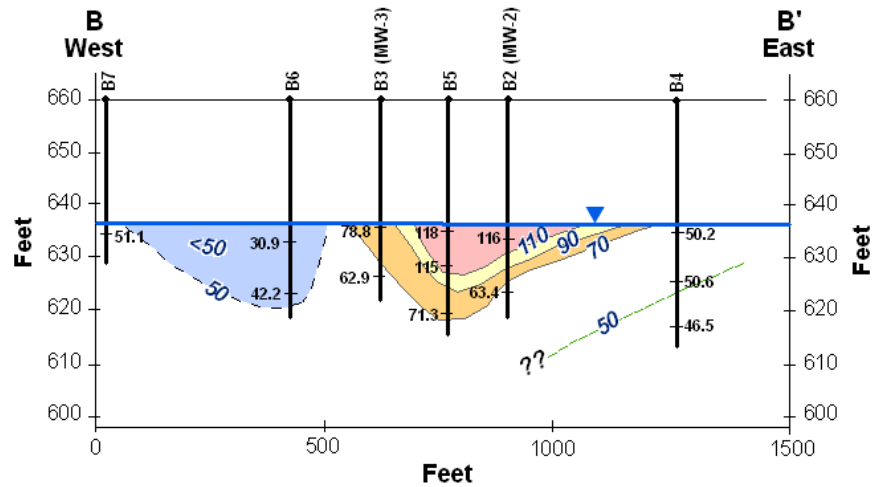
- Water levels indicate consistent flow directions to the SSW
- Chloride and TDS concentrations delineate distinct wastewater and storm water plumes, consistent with monitoring well data
- Ammonia is present in core of plume
 - Reducing conditions in plume core within oxidized ground water

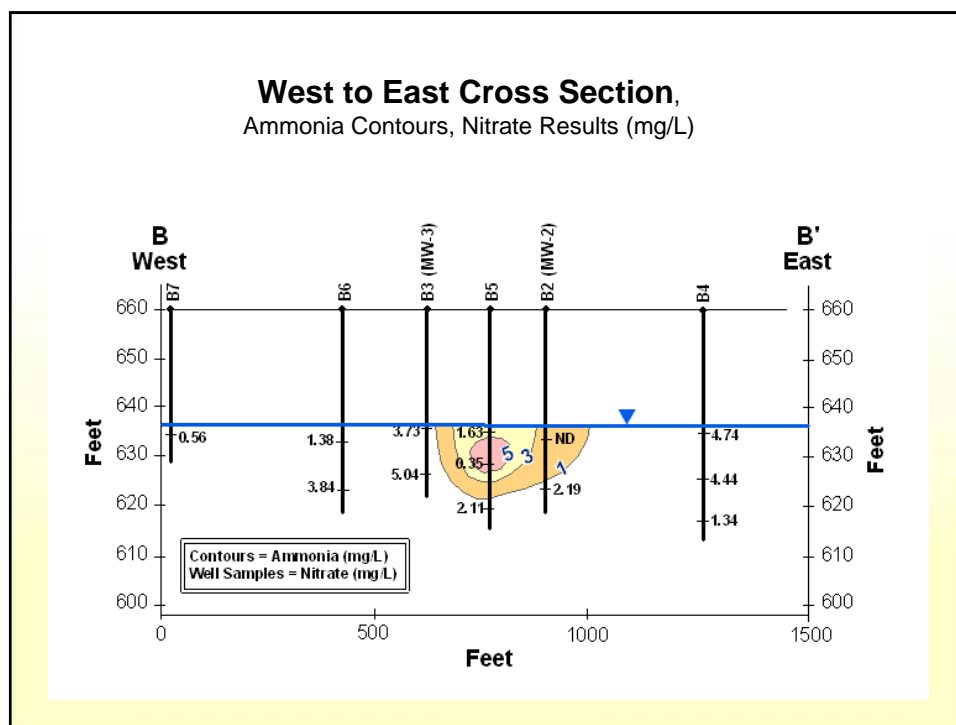
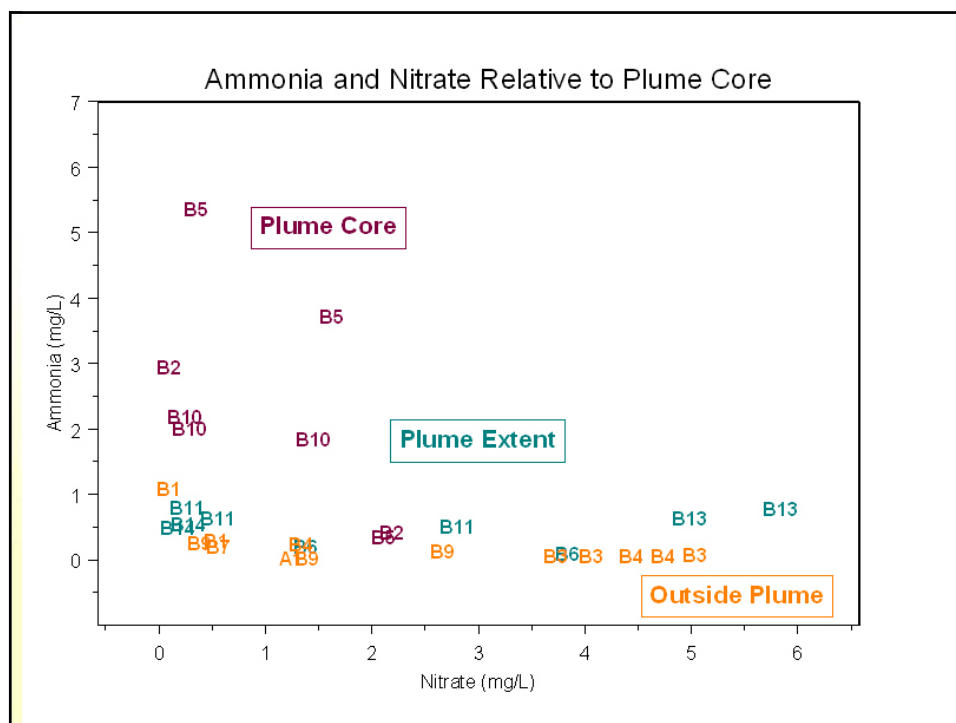






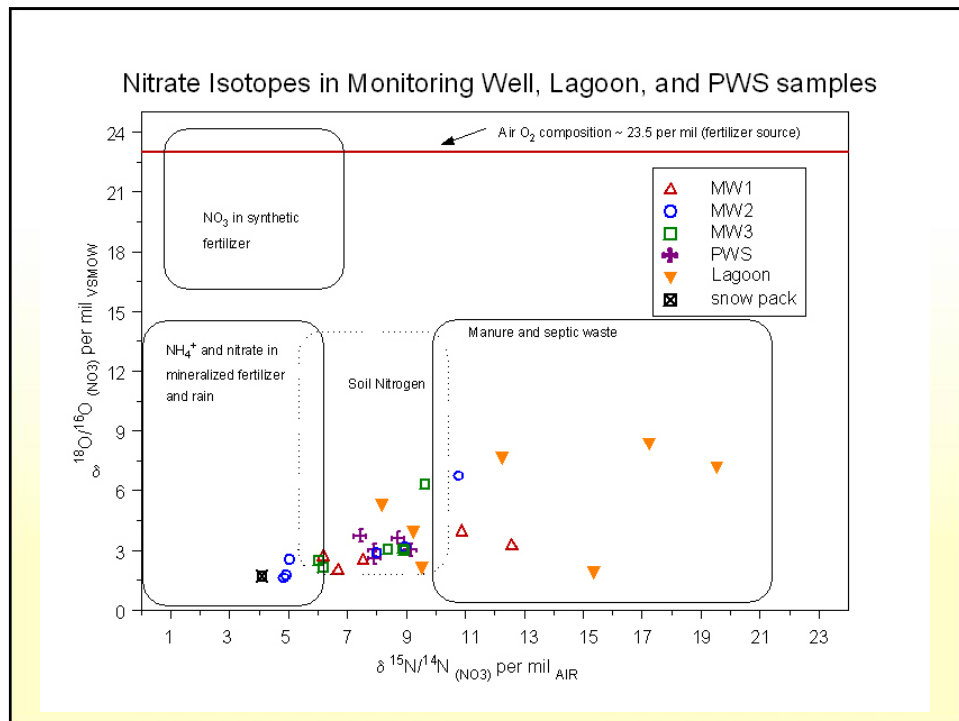
West to East Cross Section, Chloride (mg/L)

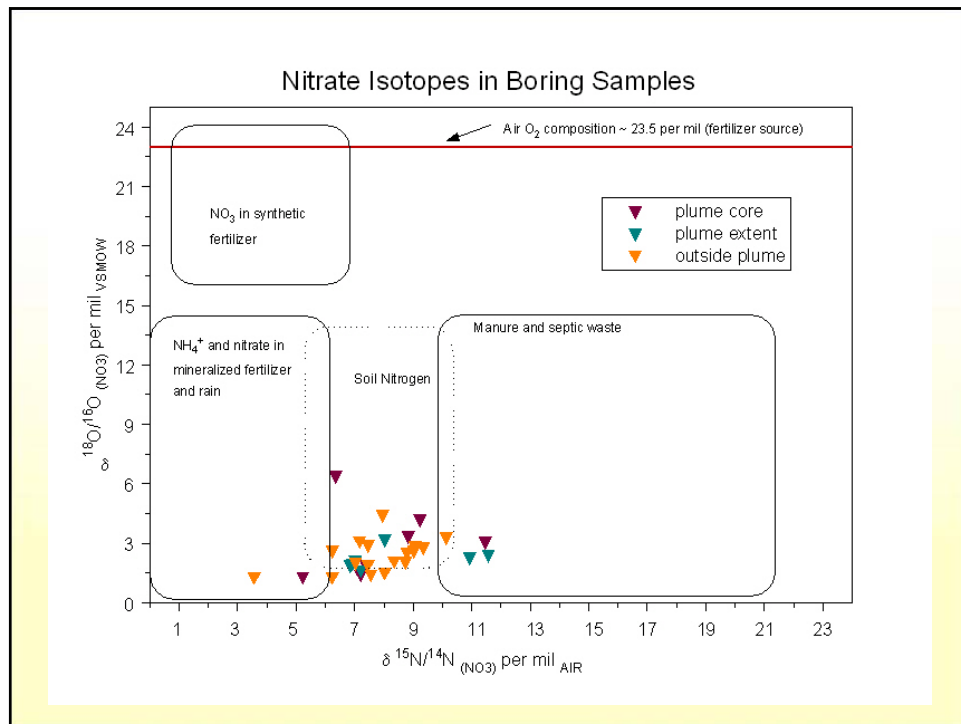




Isotope Sample Results

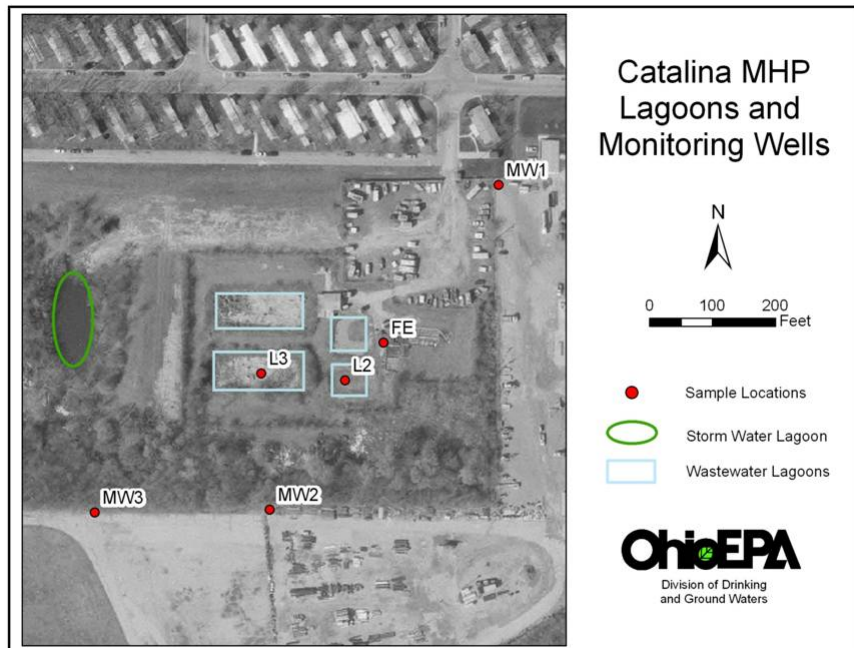
- **Stable Isotopes of nitrogen and oxygen in nitrate:**
 - Lagoon isotopes exhibit sewage signature;
 - Snow pack is most depleted;
 - Monitoring wells are variable but plot between sewage source and snow pack;
 - Boring samples generally plot in soil nitrogen field.
- **Suggests mixing of lagoon infiltrate with ground water**





Microbiologic Results

- **GW samples produced non-detect to low counts of pathogens compared to lagoons**
- **Most pathogen detections were less than 10 CFU/100 mL**
- **Elevated microbiological results do not all correlate with core of plume**



Microbiologic Indicators - Total Coliforms
(Colilert Method, colonies/100mL)

Sample Location		October-04	August-05	January-06	April-06	July-06	October-06
PWS	C1	<1	--	<1	<1	<1	<1
Storm water		>2419	--	--	--	--	--
Upgradient	MW1	--	<1	<1	<1	<1	<1
	FE	>2419	198600	--	--	--	--
Lagoons	L2	--	198280	19863	5500	579	>2500*
	L3	--	198628	--	--	--	--
Downgradient	MW2	--	<1	5	<1	<1	387
	MW3	--	3	<1	<1	<1	<1

-- Indicates no sample collected

* Sample 2/3 sediment - results inaccurate

Microbiologic Indicators - *E-coli*
#/100mL

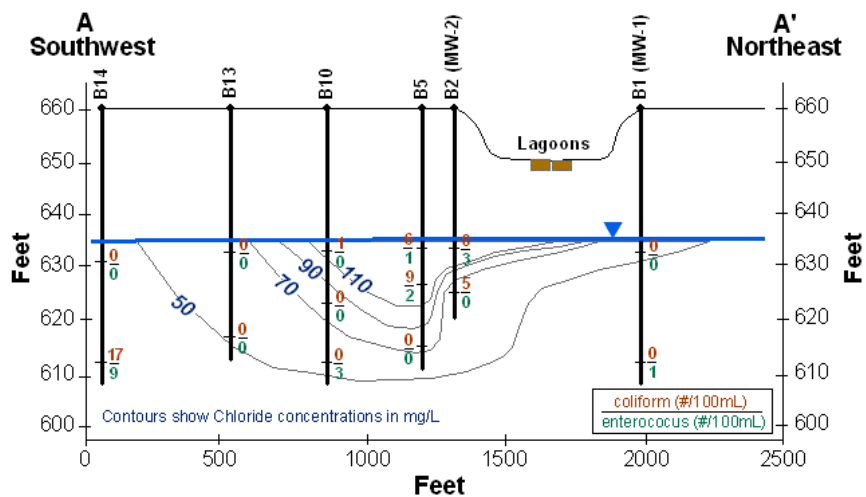
Sample Location		October-04	August-05	January-06	April-06	July-06	October-06
PWS	C1	<1	--	<1	<1	<1	<1
Storm water		228	--	--	--	--	--
Upgradient	MW1	--	-----	<1	<1	<1	<1
	FE	>2419	27230	--	--	--	--
Lagoons	L2	--	30900	4611	630	62	550*
	L3	--	32550	--	--	--	--
Downgradient	MW2	--	-----	<1	<1	<1	4
	MW3	--	-----	<1	<1	<1	<1

-- Indicates no sample collected
----- Sample collected, no results

* Sample 2/3 sediment; results inaccurate



Longitudinal Cross Section, Pathogens

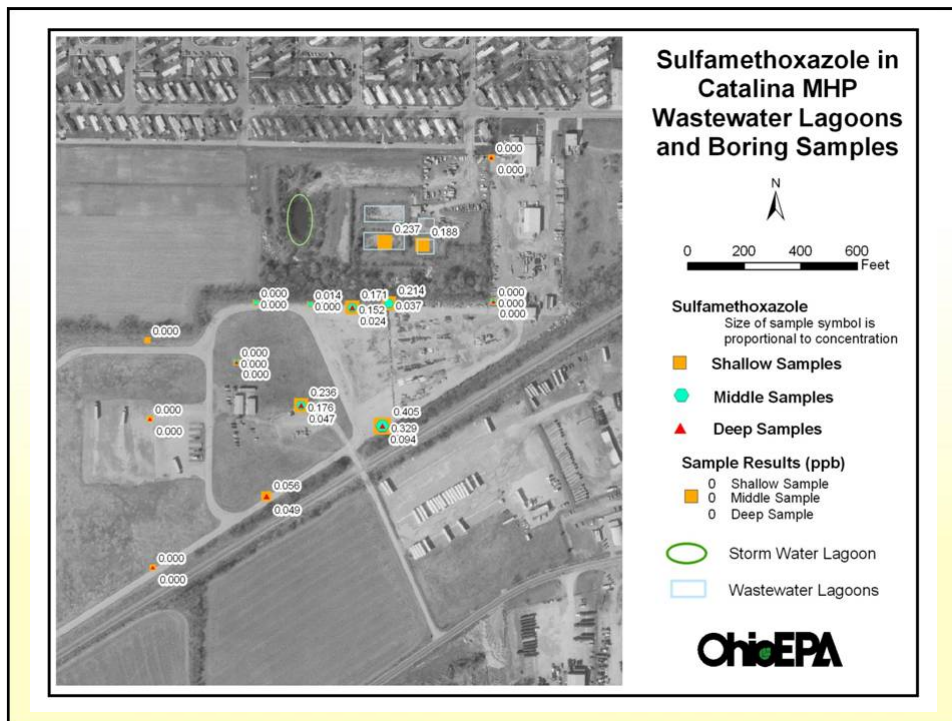


Catalina MHP F+ Phage in Boring Samples August 2005



Pharmaceutical Results

- GW samples detected sulfamethoxazole and carbamazepine in boring and monitoring wells;
- Distribution of detections consistent with the plume geometry;
- Within single boring, concentration of pharmaceuticals decrease with depth.



Catalina MHP Study Conclusions

- Wastewater plume clearly identified, GW quality impacts do not exceed inorganic MCLs;
 - Nitrate below 10 mg/L (as high as 6.0 but mostly <5.0)
- Non-detect to low counts of pathogen indicators indicates significant filtration, not perfect;
 - Pathogens below 10 cfu/100mL
- Stable isotopes in nitrate and pharmaceutical parameters consistent with infiltrate mixing with local ground water.

Study Implications

- Study results can be used to help evaluate the need for developing statewide GW discharge standards.
- Catalina MHP results document that buried valley aquifers provide significant filtration of pathogens – significantly greater than fracture controlled aquifers;
- Results allow state to focus GW Rule implementation on PWSs in fractured bedrock aquifers with thin, overlying glacial drift.



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